



Our Milky Way galaxy is not alone in the universe, but has many neighbors.

The distances between galaxies in the universe are so large that astronomers use the unit 'megaparsec' (mpc) to describe distances.

One *mpc* is about $3\frac{1}{4}$ million light years.

Hubble picture of a Ring Galaxy (AM 0644 741) at a distance of 92 mpc.

Problem 1 - The Andromeda Galaxy is $\frac{3}{4}$ mpc from the Milky Way, while the Sombrero Galaxy is 12 mpc from the Milky Way. How much further is the Sombrero Galaxy from the Milky Way?

Problem 2 - The Pinwheel Galaxy is $3\frac{4}{5}$ mpc from the Milky Way. How far is it from the Sombrero Galaxy?

Problem 3 - The Virgo Galaxy Cluster is 19 mpc from the Milky Way. About how far is it from the Pinwheel Galaxy?

Problem 4 - The galaxy Messier 81 is located $3\frac{1}{5}$ mpc from the Milky Way. How far is it from the Andromeda Galaxy?

Problem 5 - The galaxy Centaurus-A is $4\frac{2}{5}$ mpc from the Milky Way. How far is it from the Andromeda Galaxy?

Problem 6 - The galaxy Messier 63 is located about $4\frac{1}{5}$ mpc from the Milky Way. How far is it from the Pinwheel galaxy?

Problem 7 - The galaxy NGC-55 is located $2\frac{1}{3}$ mpc from the Milky Way. How far is it from the Andromeda galaxy?

Problem 8 - In the previous problems, which galaxy is $2\frac{1}{15}$ mpc further from the Milky Way than NGC-55?

Extra for Experts: How far, in light years, is the Virgo Galaxy Cluster from the Milky Way?

Answer Key

Problem 1 - The Andromeda Galaxy is $\frac{3}{4}$ mpc from the Milky Way, while the Sombrero Galaxy is 12 mpc from the Milky Way. How much further is the Sombrero Galaxy from the Milky Way? Answer: $12 \text{ mpc} - \frac{3}{4} \text{ mpc} = \mathbf{11 \frac{1}{4} \text{ mpc}}$

Problem 2 - The Pinwheel Galaxy is $3 \frac{4}{5}$ mpc from the Milky Way. How far is it from the Sombrero Galaxy? Answer: $12 \text{ mpc} - 3 \frac{4}{5} \text{ mpc} = \mathbf{8 \frac{1}{5} \text{ mpc}}$

Problem 3 - The Virgo Galaxy Cluster is 19 mpc from the Milky Way. About how far is it from the Pinwheel Galaxy? Answer: $19 \text{ mpc} - 3 \frac{4}{5} \text{ mpc} = \mathbf{15 \frac{1}{5} \text{ mpc}}$.

Problem 4 - The galaxy Messier 81 is located $3 \frac{1}{5}$ mpc from the Milky Way. How far is it from the Andromeda Galaxy? Answer: $3 \frac{1}{5} \text{ mpc} - \frac{3}{4} \text{ mpc} = \frac{16}{5} \text{ mpc} - \frac{3}{4} \text{ mpc} = \frac{64}{20} \text{ mpc} - \frac{15}{20} \text{ mpc} = \frac{49}{20} \text{ mpc} = \mathbf{2 \frac{9}{20} \text{ mpc}}$.

Problem 5 - The galaxy Centaurus-A is $4 \frac{2}{5}$ mpc from the Milky Way. How far is it from the Andromeda Galaxy? Answer: $4 \frac{2}{5} \text{ mpc} - \frac{3}{4} \text{ mpc} = \frac{88}{5} \text{ mpc} - \frac{15}{20} \text{ mpc} = \frac{73}{20} \text{ mpc} = \mathbf{3 \frac{13}{20} \text{ mpc}}$

Problem 6 - The galaxy Messier 63 is located about $4 \frac{1}{5}$ mpc from the Milky Way. How far is it from the Pinwheel galaxy? Answer: $4 \frac{1}{5} \text{ mpc} - 3 \frac{4}{5} \text{ mpc} = \frac{21}{5} \text{ mpc} - \frac{19}{5} \text{ mpc} = \mathbf{\frac{2}{5} \text{ mpc}}$.

Problem 7 - The galaxy NGC-55 is located $2 \frac{1}{3}$ mpc from the Milky Way. How far is it from the Andromeda galaxy? Answer: $2 \frac{1}{3} \text{ mpc} - \frac{3}{4} \text{ mpc} = \frac{7}{3} \text{ mpc} - \frac{3}{4} \text{ mpc} = \frac{28}{12} \text{ mpc} - \frac{9}{12} \text{ mpc} = \frac{19}{12} \text{ mpc} = \mathbf{1 \frac{7}{12} \text{ mpc}}$.

Problem 8 - In the previous problems, which galaxy is $2 \frac{1}{15}$ mpc further from the Milky Way than NGC-55? Answer; NGC-55 is located $2 \frac{1}{3}$ mpc from the Milky Way, so the mystery galaxy is located $2 \frac{1}{3} \text{ mpc} + 2 \frac{1}{15} \text{ mpc} = \frac{7}{3} \text{ mpc} + \frac{31}{15} \text{ mpc} = \frac{35}{15} \text{ mpc} + \frac{31}{15} \text{ mpc} = \frac{66}{15} \text{ mpc} = 4 \frac{6}{15} \text{ mpc}$ or $\mathbf{4 \frac{2}{5} \text{ mpc}}$. This is the distance to the Centaurus-A galaxy.

Extra for Experts: How far, in light years, is the Virgo Galaxy Cluster from the Milky Way?

Answer: The distance is 19 megaparsecs, but 1 parsec equals $3 \frac{1}{4}$ light years, so the distance to the Virgo Cluster is

$19 \text{ million parsecs} \times (3 \frac{1}{4} \text{ lightyears/parsec}) = 19 \times 3 \frac{1}{4} = 19 \times \frac{12}{4} = \frac{228}{4} = \mathbf{57 \text{ million light years}}$

Note: *Galaxies are actually located in 3-dimensional space, but to make this problem work we have assumed that the galaxies are all located along a straight line with the Milky Way at the center.*